ASD Diagnostics Group

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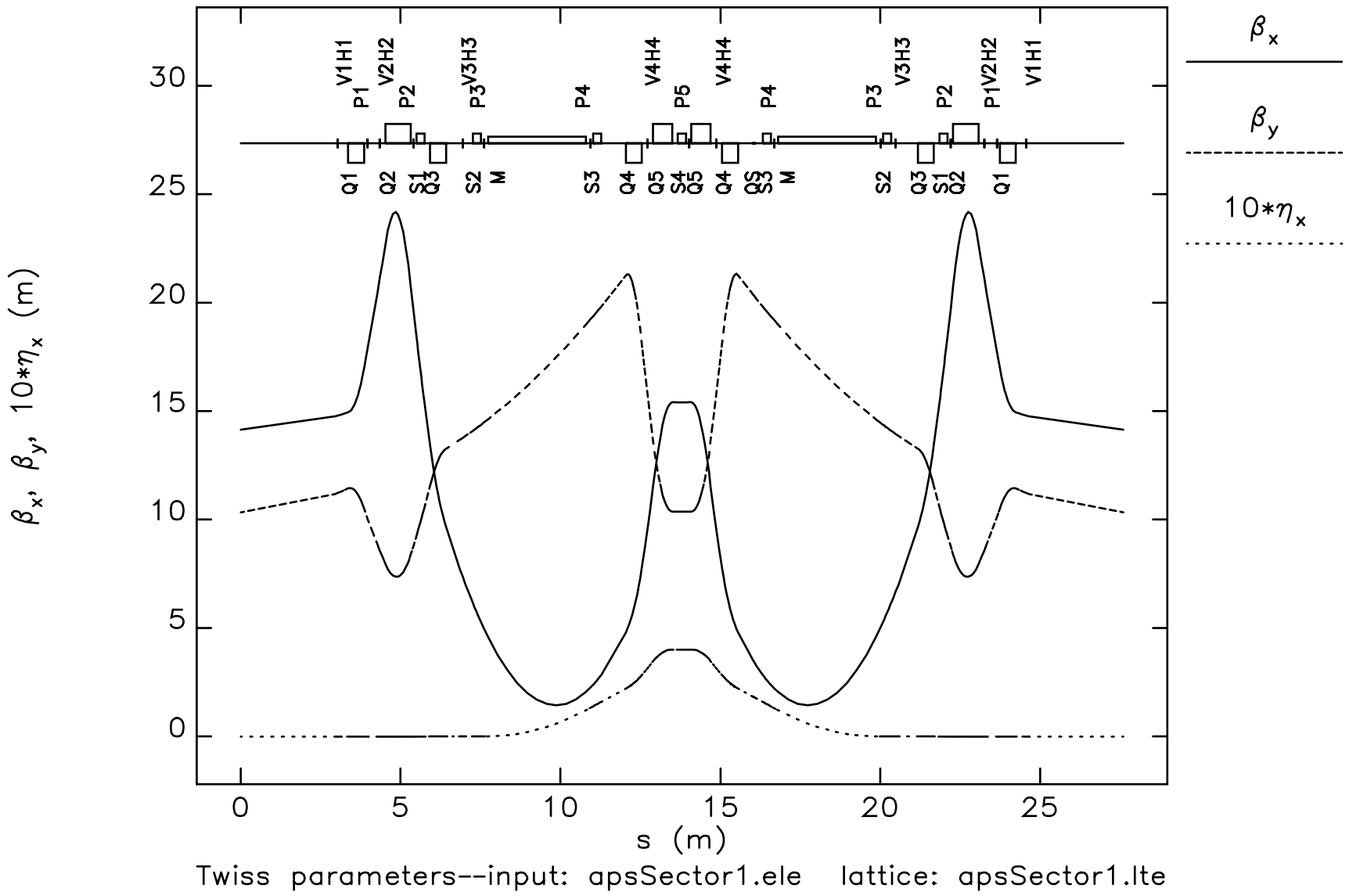
Diagnostics

- RF beam position monitor status & plans
- X-ray BPM plans
- Feedback orbit control
- Sector 35 photon diagnostics status
- LDRD - Low-energy undulator diagnostics


V1H1
P1
V2H2
P2
P3V3H3
P4
V4H4
P5
V4H4
P4
P3
V3H3
P2
P1V2H2
V1H1
Q1
Q2
S1
Q3
S2
M
S3
Q4
Q5
S4
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QS
S3
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S2
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S1
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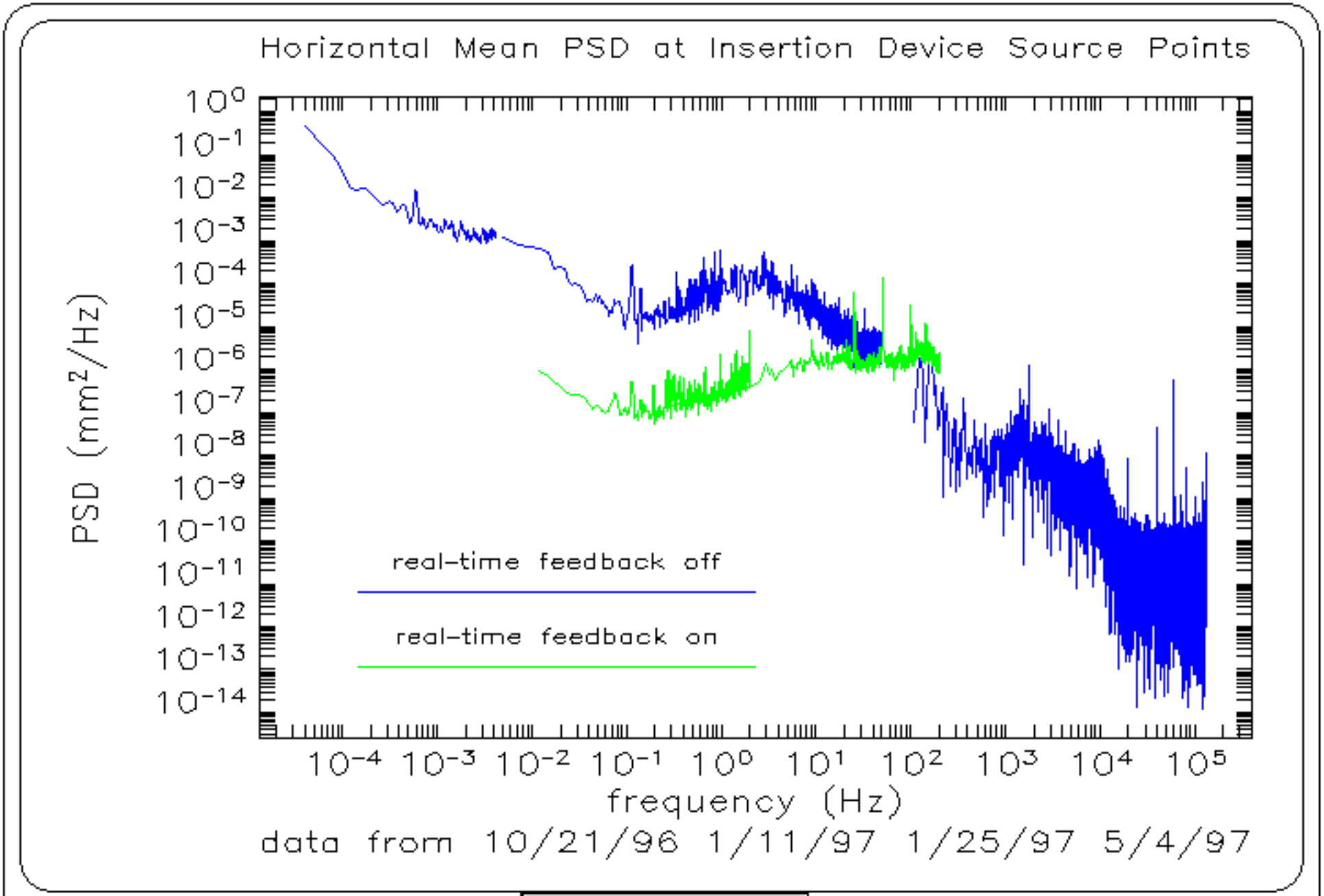
30
25
20
15
10
5
0
0
5
10
15
20
25
s (m)
β_x, β_y, $10*\eta_x$ (m)
β_x
β_y
$10*\eta_x$
Twiss parameters--input: apsSector1.ele lattice: apsSector1.lte

RF Beam Position Monitor
Status & Plans

- Present system is generally meeting beam stability specifications (±5% of beam size).
- Monopulse system limitations impact storage ring bunch pattern (dead-time requirement).
- RF front-end components lossy (14 dB insertion loss), requiring “target cluster” current > 4 mA.
- Long-term drift/intensity dependence continues to be a challenge.



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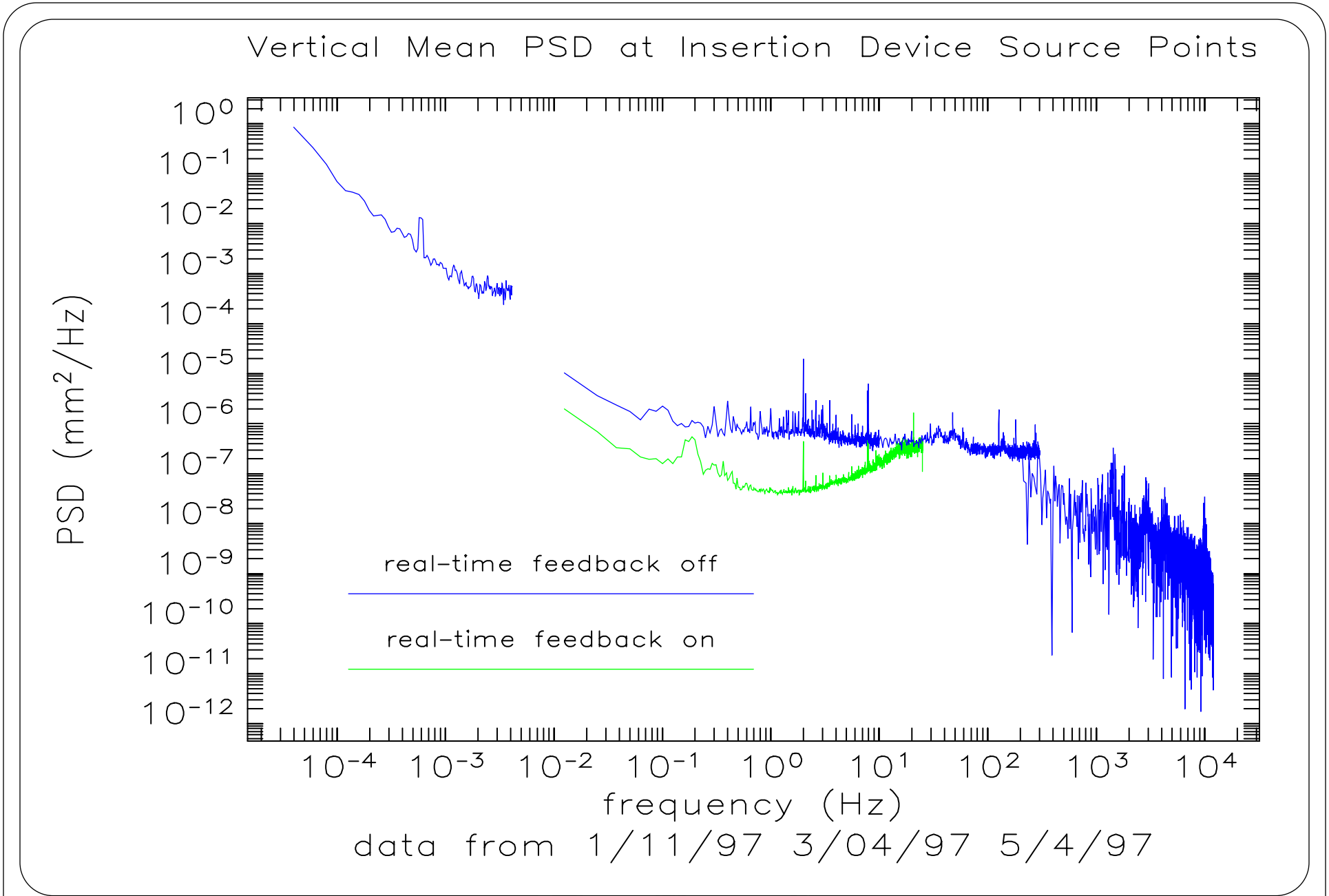

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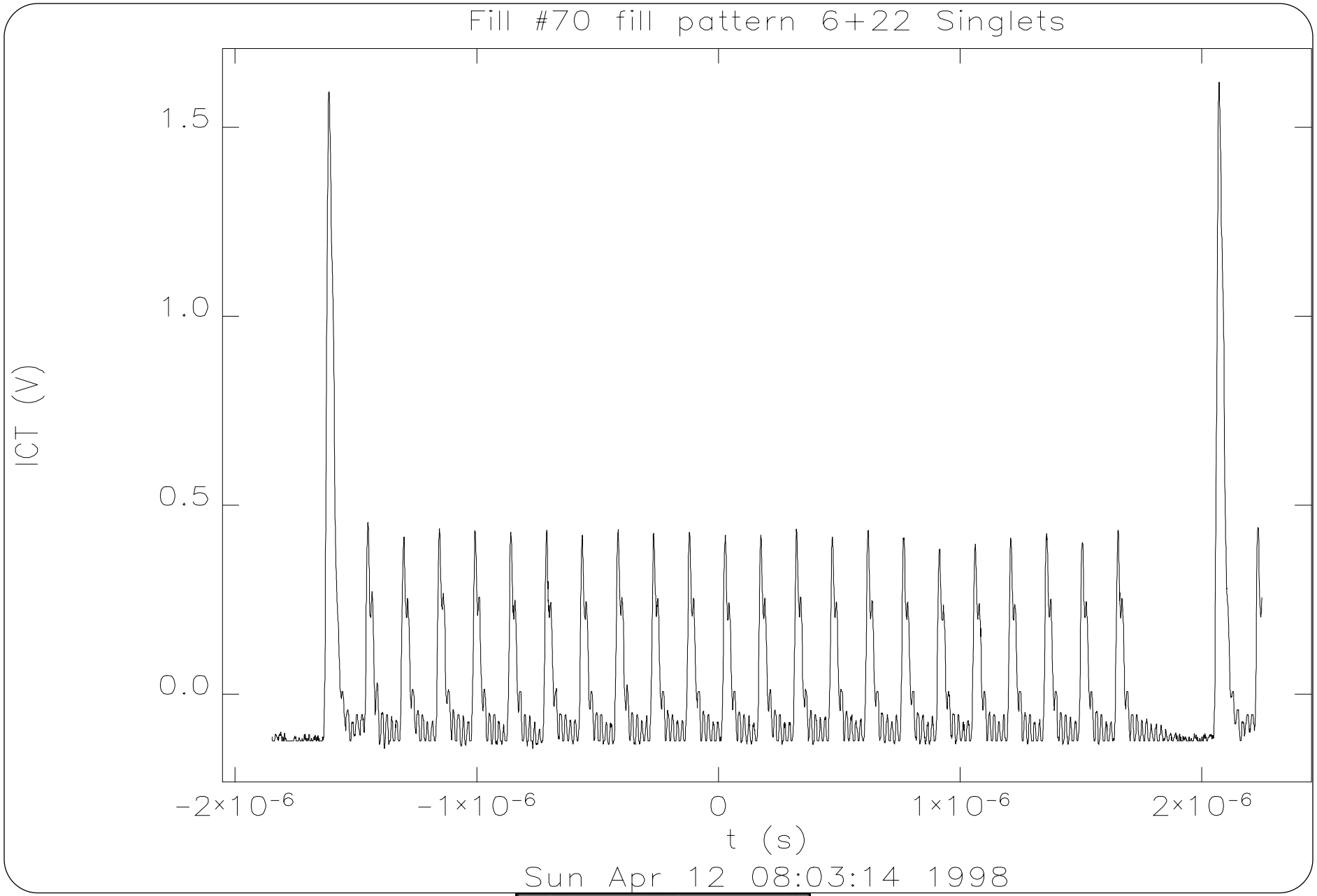

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RF Beam Position Monitor
Status & Plans (cont'd)

- Plan to replace passive rf front-end to enhance signal strength (Phase I) and reduce dead time requirement to < 100 ns with further improvement in signal strength (Phase II).
- Monopulse BPM Upgrade Review 4/24/98

  Comments from Review Committee:

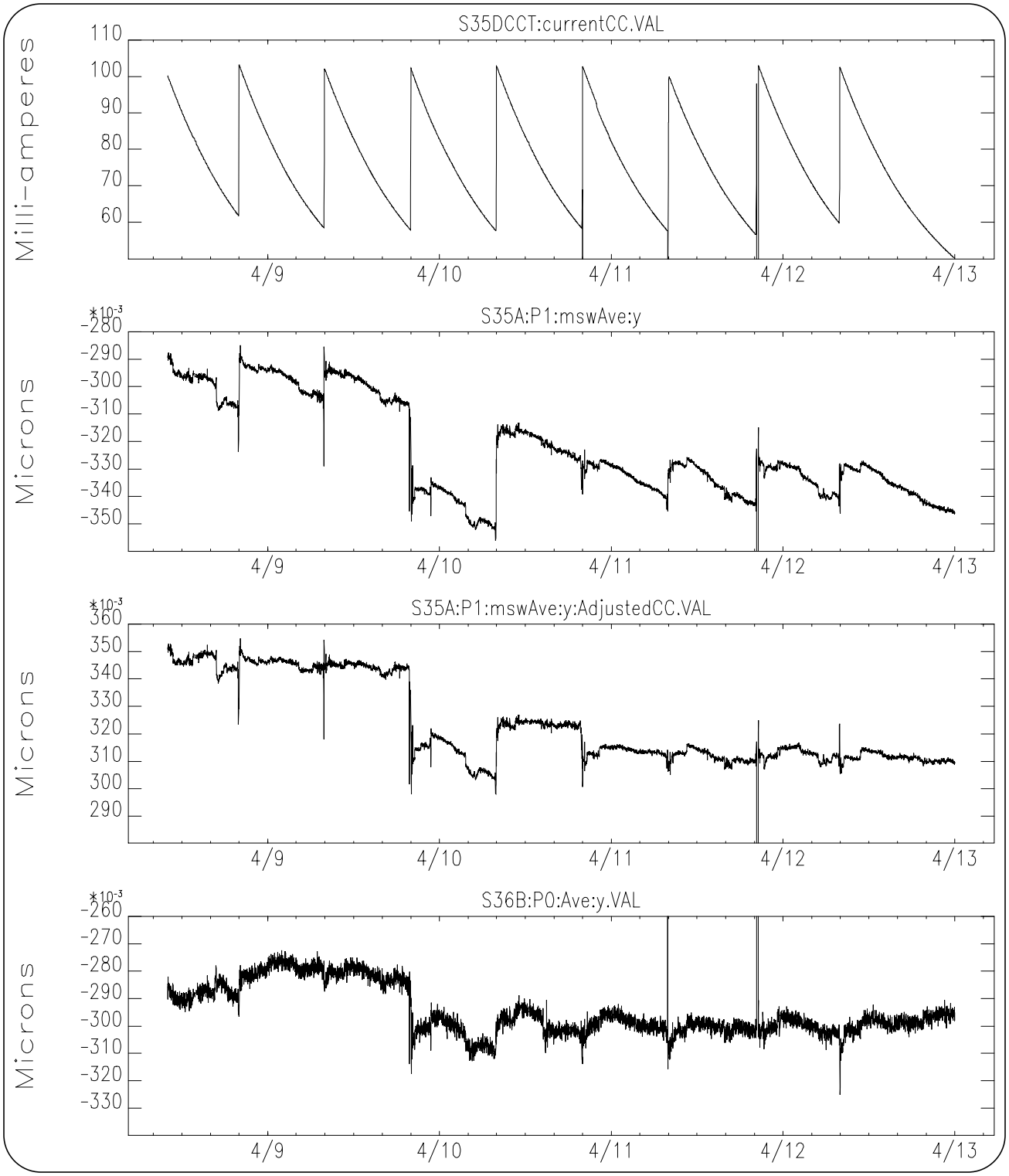
  - **"The phased approach that was presented is reasonable and conservative"**
  - **"The plan to evaluate several implementations with beam-based studies is sensible"**
- Testing with Phase I mods completed 4/98.
- Schedule is to install one full sector with Phase I and Phase II modifications (discrete components) for testing with beam in early CY 1999.
- Full ring upgrade by summer, 1999.

RF Beam Position Monitor Status & Plans (cont'd)

- Commercially available narrow-band (300 Hz) switched receivers are in-house (42 units + 8 spares).
- To be located at 21 ID source points.
- Superior long-term drift performance and reduced bunch pattern dependence for local feedback/source point control.
- Installation/commissioning of up to eight sectors (sixteen channels) for each of the July, October, and December shutdowns is planned.
- Complete system planned for commissioning in early CY 1999.

Monopulse vs. Switched Receiver Comparison

(Vertical)



Courtesy of O. Singh, ANL

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XFD/ASD X-ray Stability Task Force (XAXSTF)

- Interdivisional group brought into existence at ALD request in early 1997 to investigate methods for improving beam stabilization
- Om Singh, ASD-DIAG chair
- Concept:

  Insertion device X-BPMs subject to influence of variable stray radiation sources (bending magnets, quadrupoles, correctors)

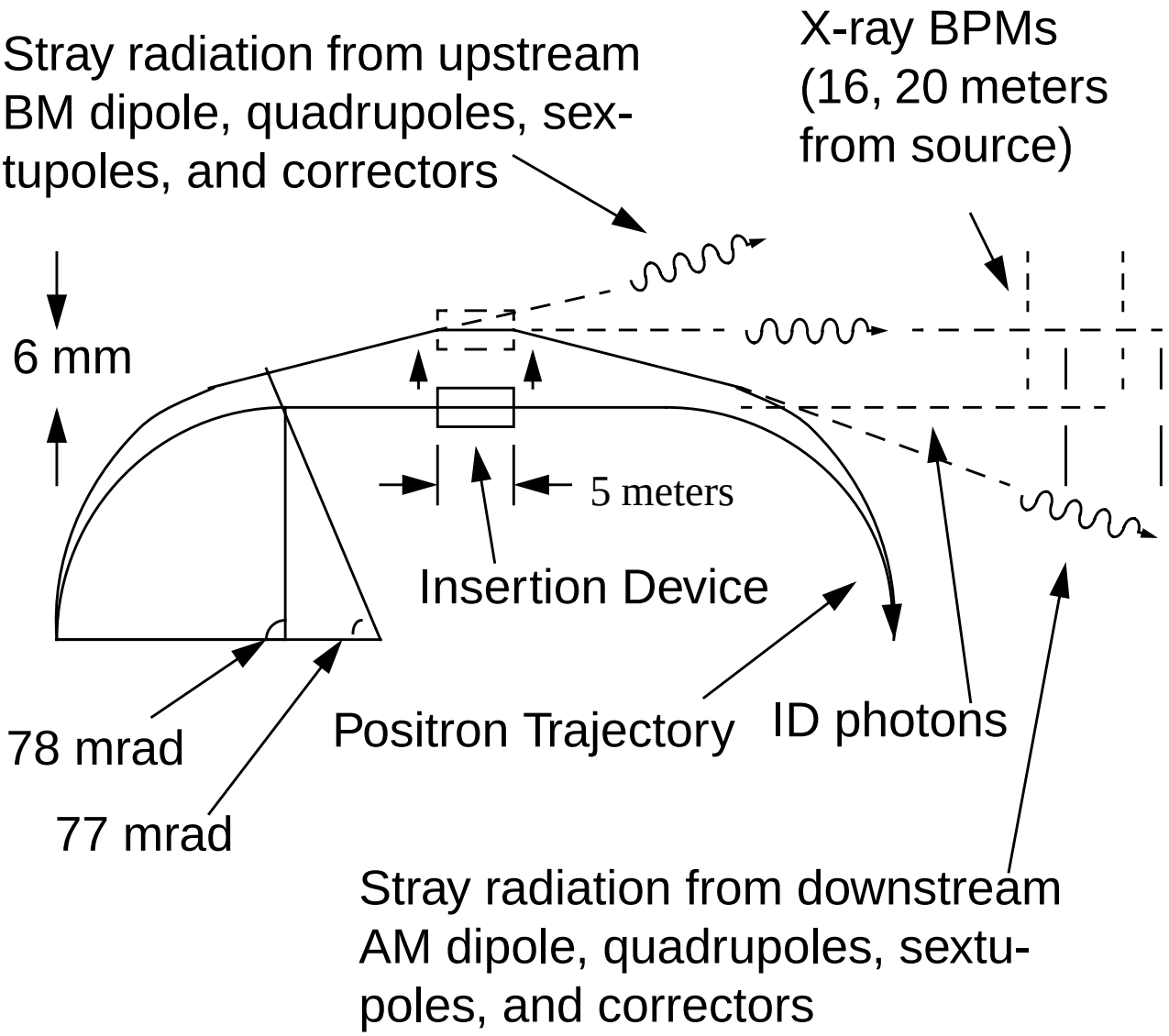
  Introduction of chicane in lattice eliminates stray radiation from X-BPM field of view

- Logistics, ray tracing studies, machine studies (3/97 - present) show feasibility of concept
- Sector 34 chosen for trial of concept
  - **Insertion device, front end in place**
  - **User beamline scheduled for CY 1999**
  - **Ring mechanical modifications scheduled for 10/98**

XFD/ASD X-ray Stability Task Force (XAXSTF)

- Commercial rf BPMs, BM & ID X-BPMs, plus monopulse BPM diagnostics available for comparison in Sector 34.
- Potential exists for true sub-micron beam position measurement and stabilization.
- Novel ideas, i.e., use of radiation from corrector magnets for x-ray beam position independent of insertion device gap, will be investigated.
- Special purpose X-BPM blade actuator with large scan range will be used to map radiation fields in large aperture.

Concept for Elimination of X-BPM Background Signals



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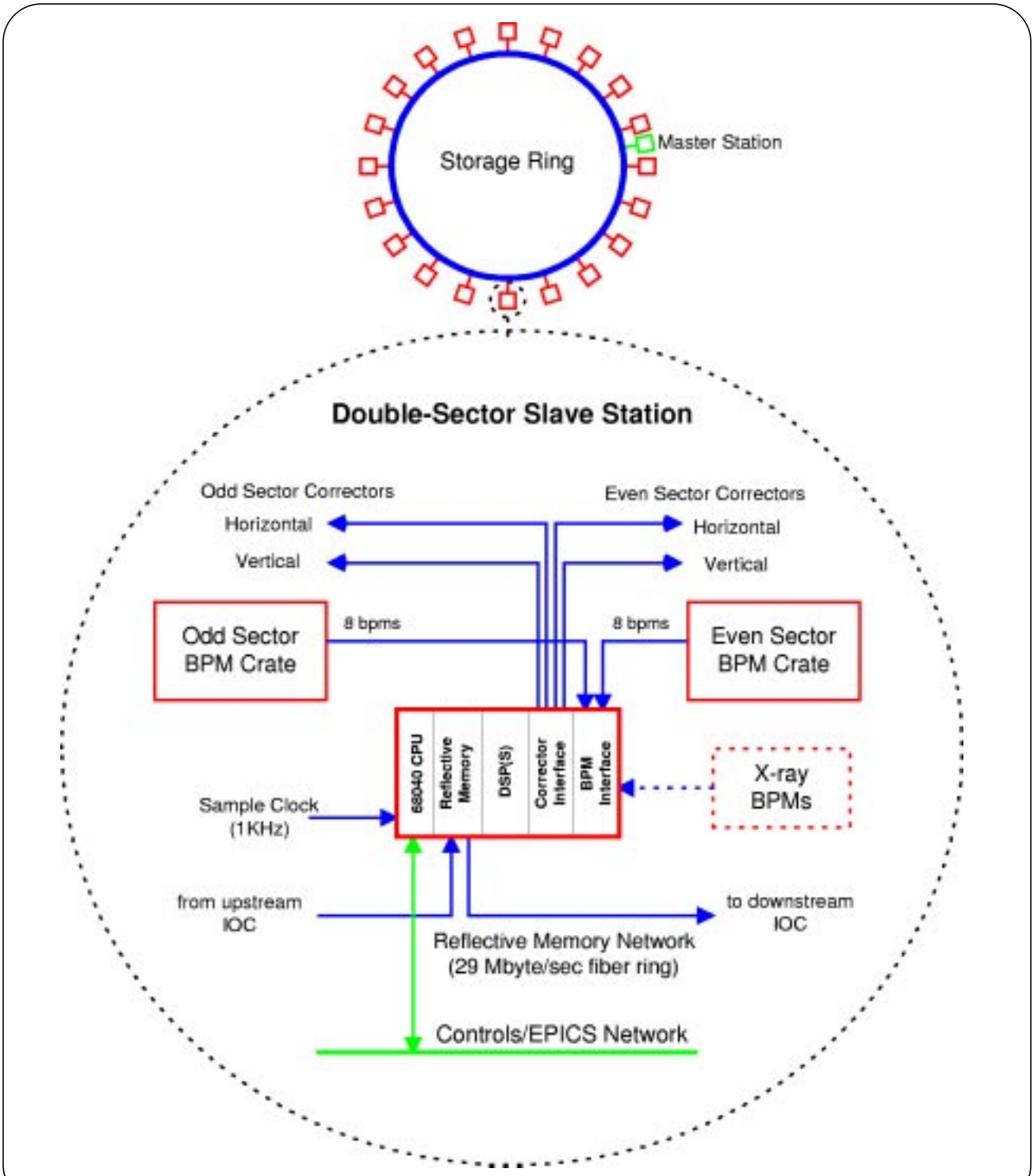
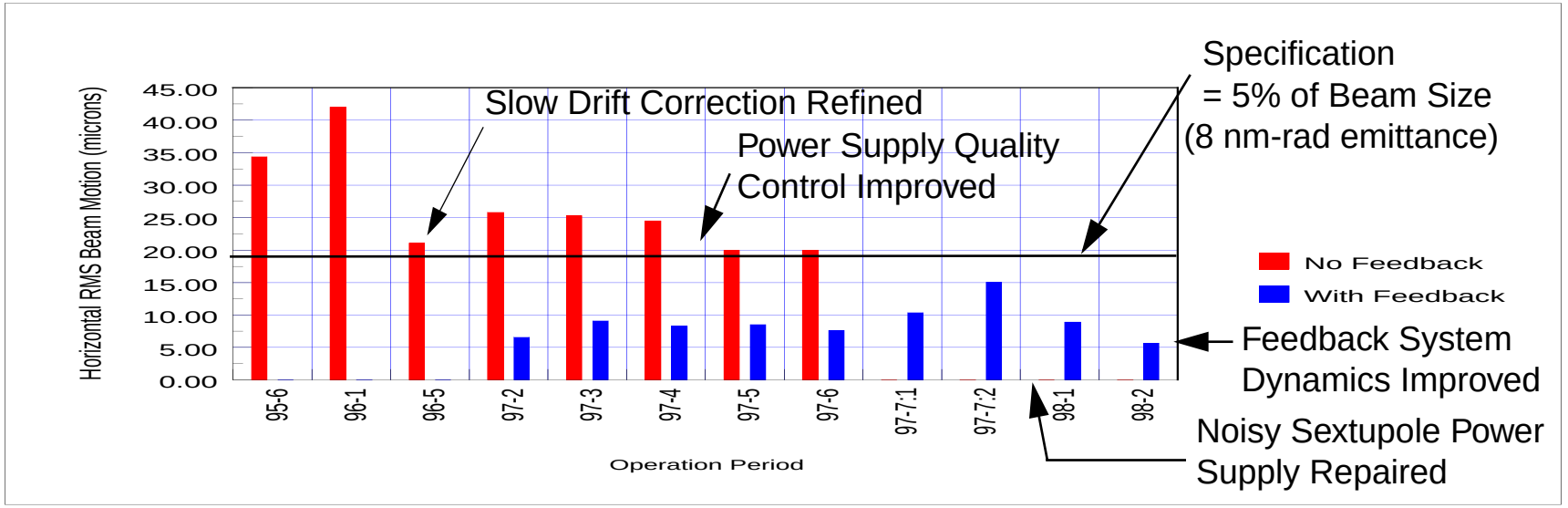
Real-Time Closed Orbit Feedback

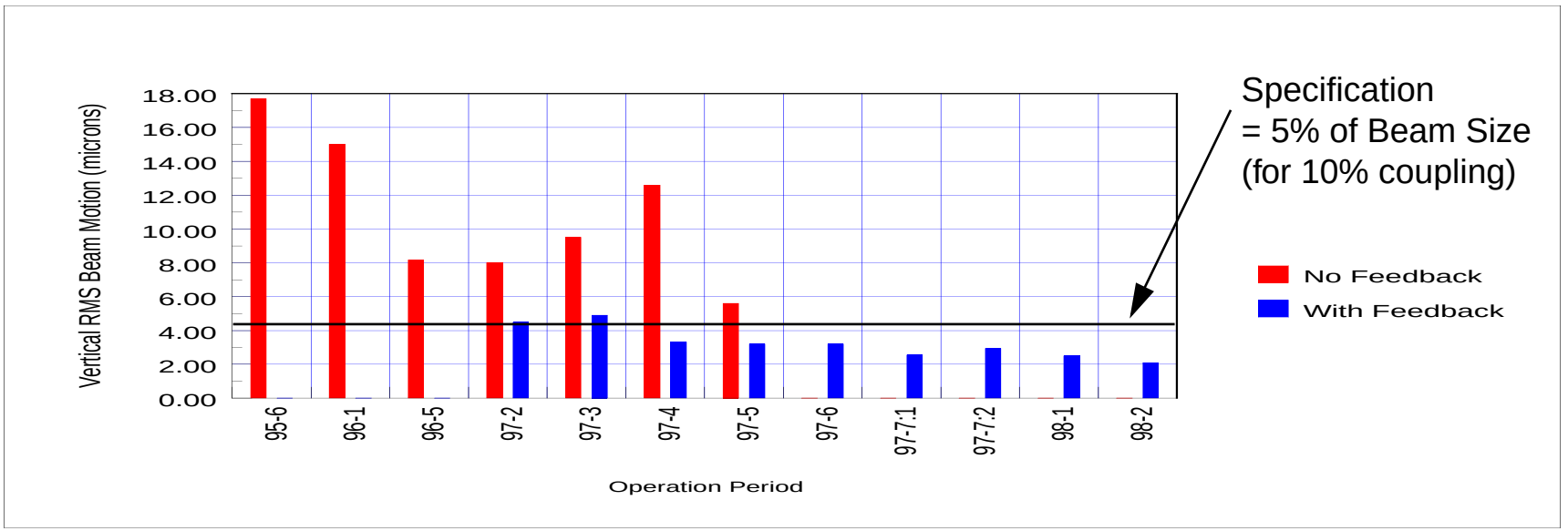
(John Carwardine, Frank Lenkszus)

- Commissioned 7/97 during user beam operation.
- Beam stability better than 2.5 microns rms vertical, 5 microns rms horizontal, (.01 - 30 Hz).
- Employs up to 160 BPMs and 38 correctors.
- Performs all-digital real-time global correction at 1 kHz; 2 kHz starting 5/98.
- Provides powerful diagnostic for identification of noise sources and malfunctioning BPMs.
- Upgrade to use up to 80 correctors in process for improved performance.


Storage Ring
Master Station
Double-Sector Slave Station
Odd Sector Correctors
Horizontal
Vertical
Even Sector Correctors
Horizontal
Vertical
Odd Sector BPM Crate
8 bpms
8 bpms
Even Sector BPM Crate
68040 CPU
Reflective Memory
DSP(S)
Corrector Interface
BPM Interface
X-ray BPMs
Sample Clock (1KHz)
from upstream IOC
to downstream IOC
Reflective Memory Network
(29 Mbyte/sec fiber ring)
Controls/EPICS Network

APS Horizontal and Vertical
Beam Position Stability History (DC - 30 Hz)



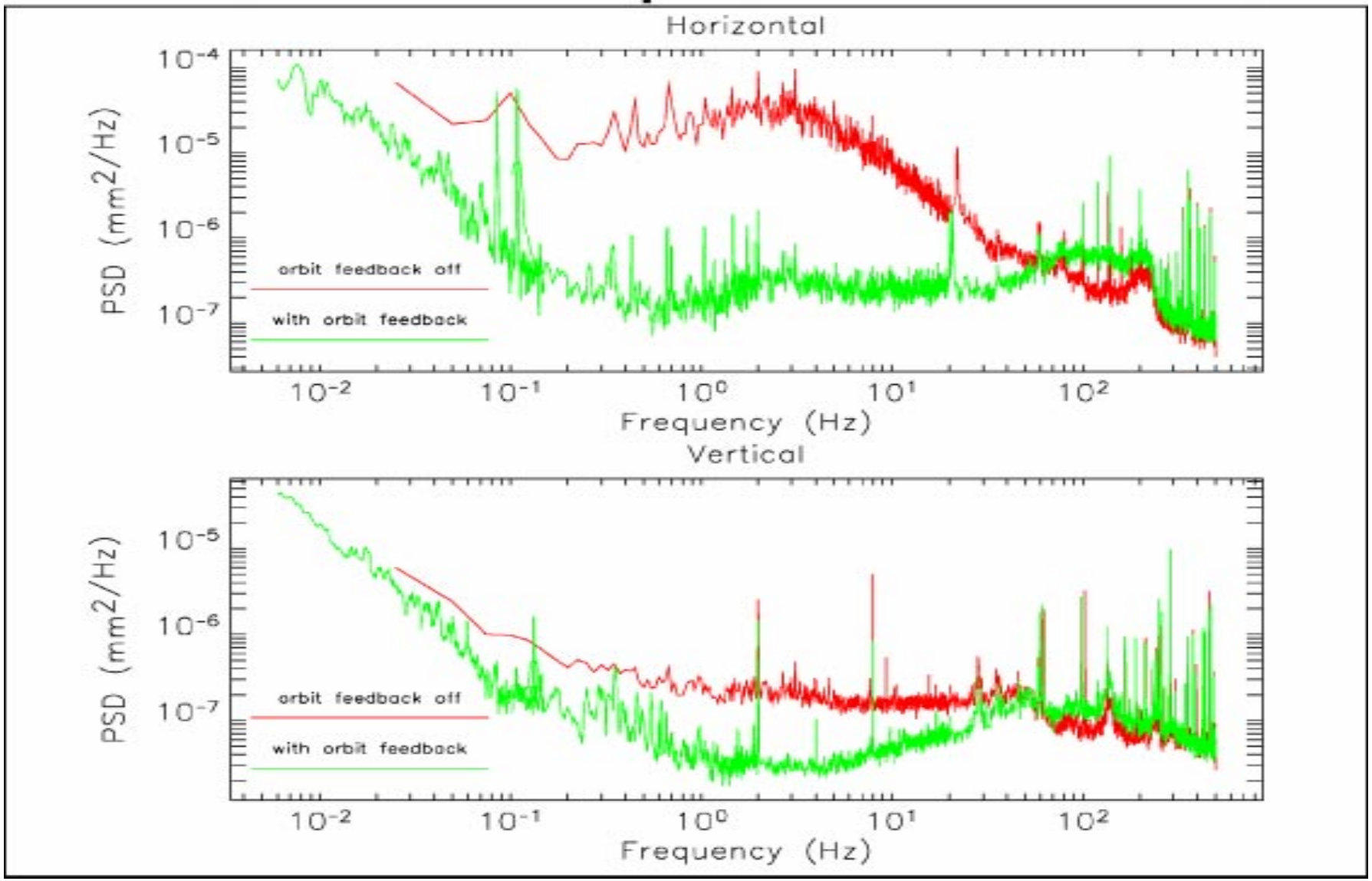


Orbit Stability at Insertion-Device Source Points

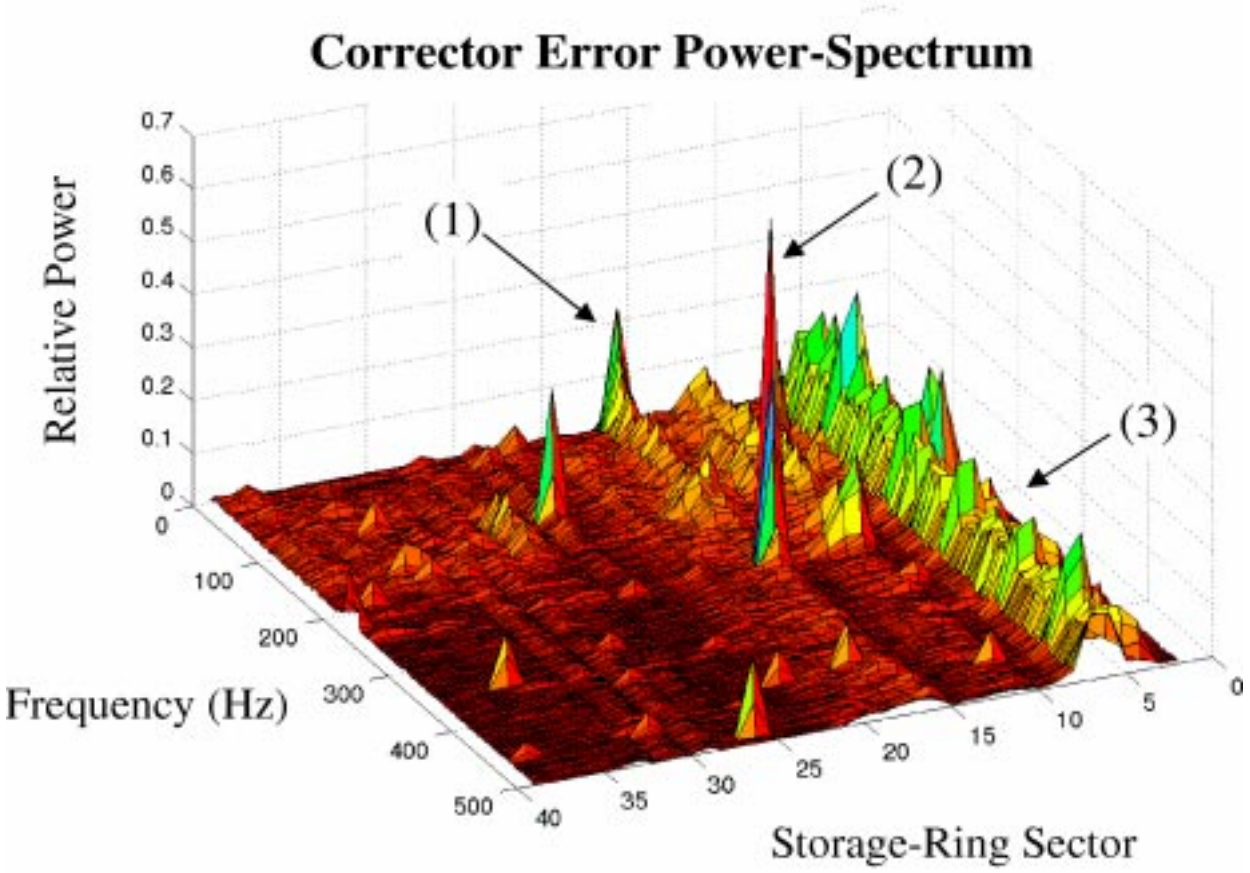
	Horizontal		Vertical	
	No F/B	F/B on	No F/B	F/B on
Required orbit stability (rms) (with 10% x-y coupling)	17.5μm		4.5μm	
Orbit motion 0.016Hz-30Hz (rms)	18.4μm	4.4μm	3.1μm	1.8μm
Orbit motion 0.25Hz-500Hz (rms)	20μm	13.2μm	7.4μm	7.5μm
Beam size at I.D. source points (rms) (inferred from S35BM @ 100mA)	335μm		18μm	
Beta at I.D. source points (design)	17m		3m	

Measurements were taken during the APS "98-2" user run with 1% x-y coupling

Orbit Motion Power Spectra at ID Source Points



Roadmap of Horizontal Sources (September 1997)



(1) Low-frequency random noise from sextupole power supply with poor regulation.
(2) Narrow-band source at 248Hz from oscillating corrector power supply.
(3) Broad-band noise caused by bad BPM in sector 6 (not real orbit motion).

Sector 35 Beam Diagnostics Photon Beamlines

Recent Results

- First measurements of injection process for top-up studies using a dual-sweep streak camera and a gated camera
- First measurements on a stored beam with an x-ray synchroscan streak camera
- Low vertical beta lattice beam size measurements
- On-line logging of beam size and position as process variables

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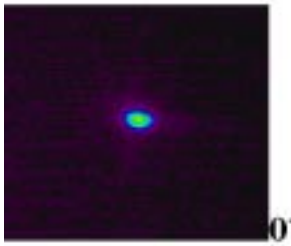
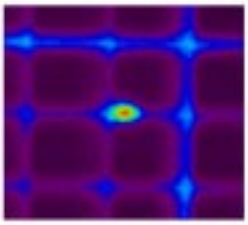
4. GATED CAMERA IMAGES (1/19/98)

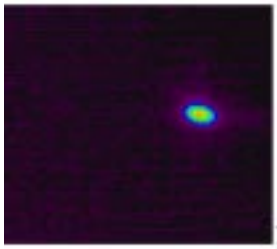
Single turn images (first 12 turns, file 02 .. 15):



0° (Beam image only)



0° (with 2 mm × 2mm grid)



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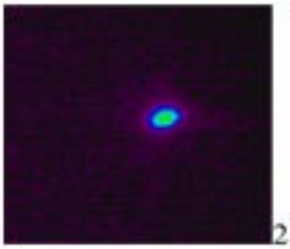

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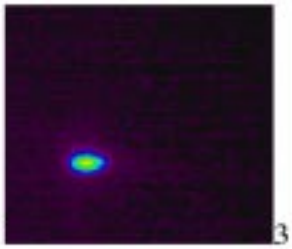

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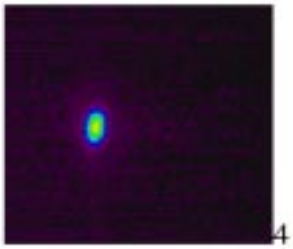

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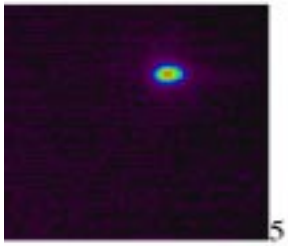

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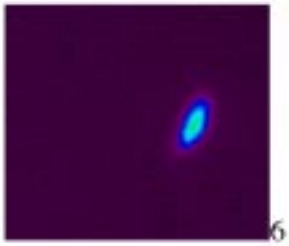

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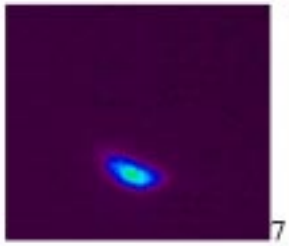

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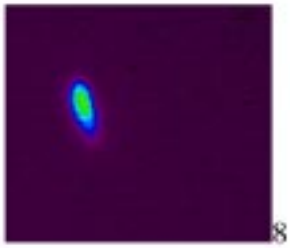

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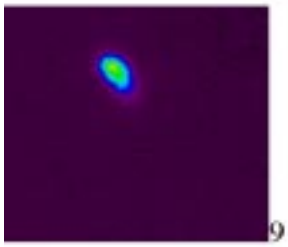

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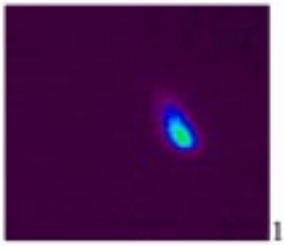

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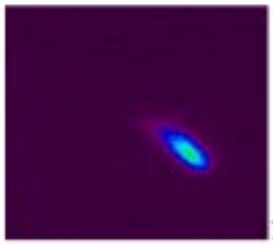

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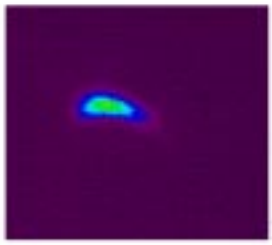

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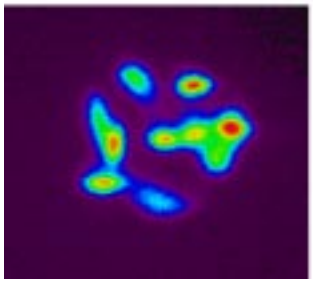
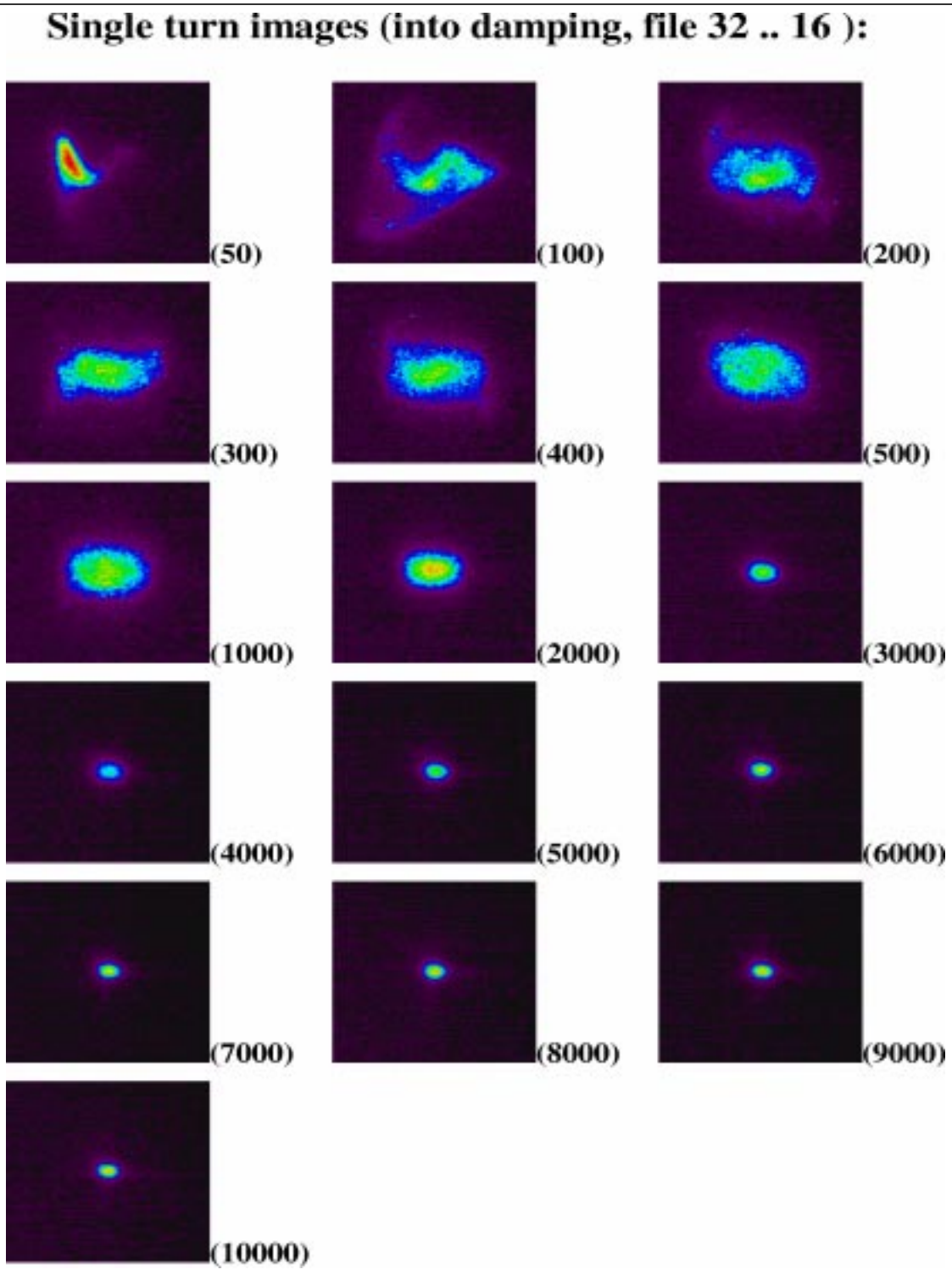


COMBINED IMAGES 0°→9


Single turn images (into damping, file 32 .. 16):
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(200)
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(4000)
(5000)
(6000)
(7000)
(8000)
(9000)
(10000)

FY98/99 Sector 35 Plans

35-ID/AM Sources

- Fabrication and installation of in-vacuum mono-chromator chamber (6/98).
- Beam studies using third harmonic ID radiation.
- Beam studies using AM dipole radiation.
- Tests of cryo-cooled CCD camera and time-resolved imaging techniques on the x-ray sources.

35-BM Source

- Completion of front-end installation.
- Transport beamline installation to 35 BM-A, C experimental stations, providing 4 x magnification with corresponding resolution improvement to approx. 10 microns rms.

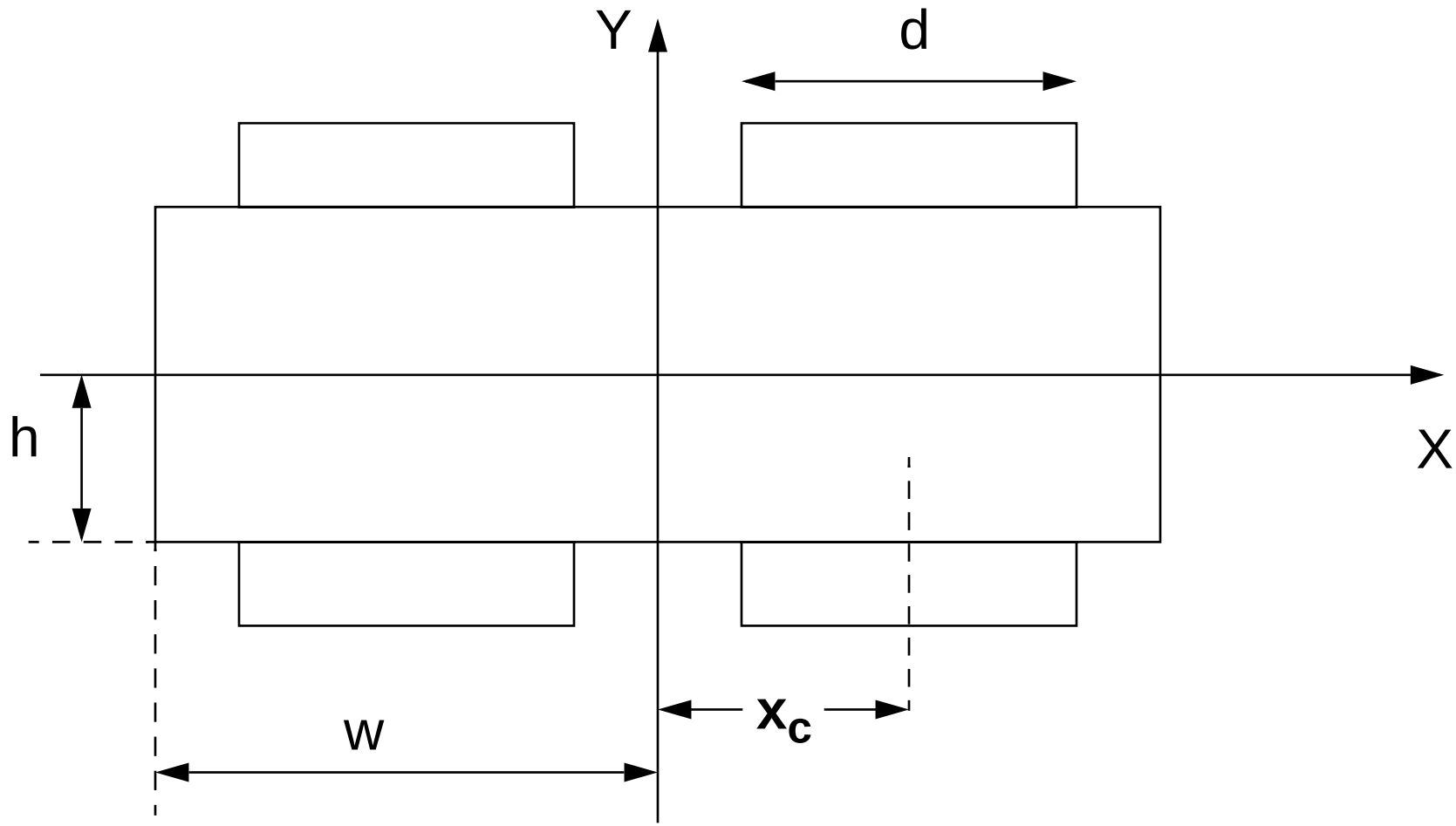
Summary - Sector 35

- Operations support provided by on-line logging of beam size.
- Stored beam quality/stability readily assessed using beam images available in MCR.
- Time-resolved imaging capability is used to study top-up dynamics issues and machine physics phenomena.
- 35-ID provides beam divergence measurements at the 1-2% coupling level. (CDR Design 10%)
- ID beamline upgrade will support third harmonic operations and measurement capability in the 0.3% coupling domain.

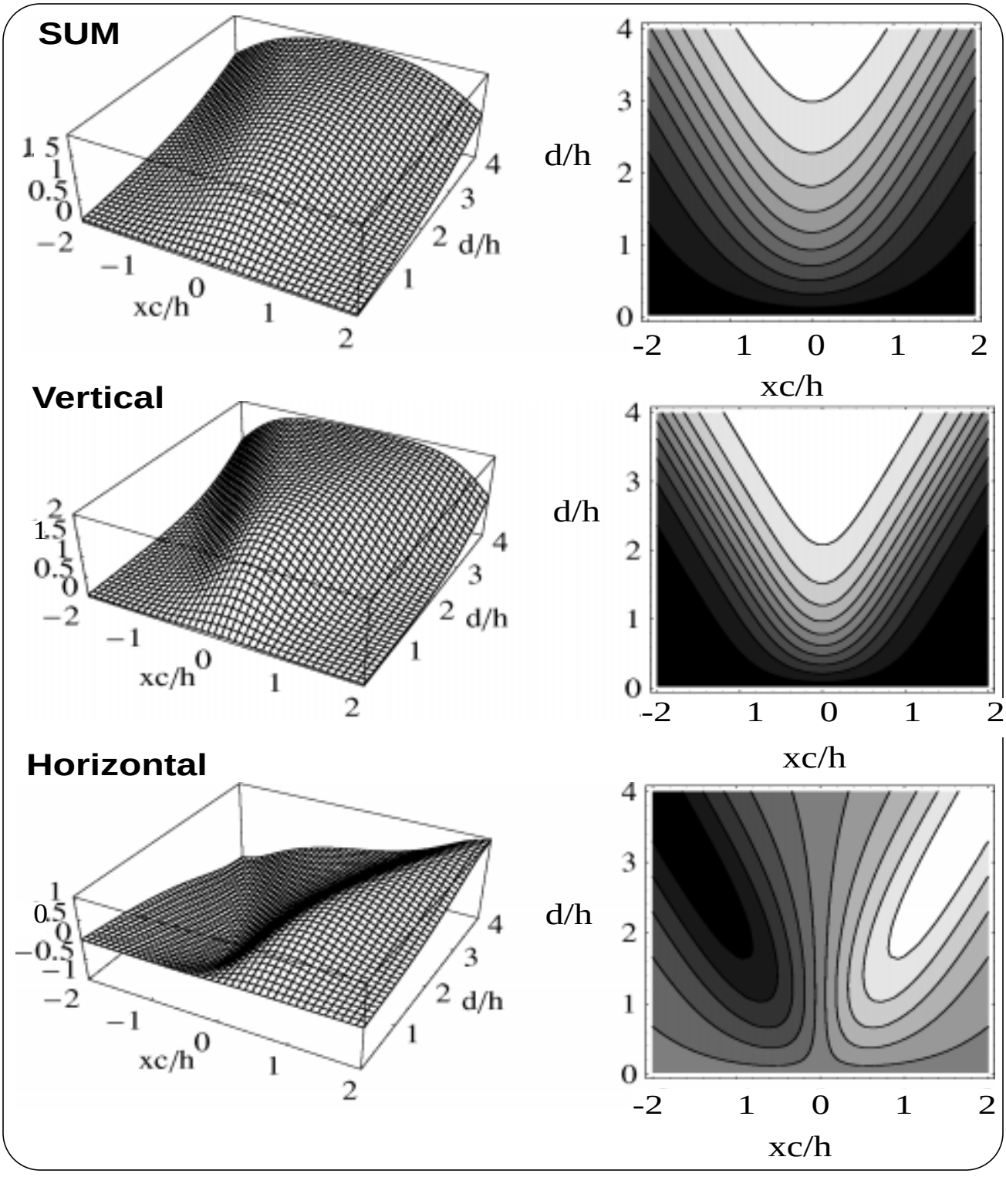
Low-Energy Undulator Test Line (LEUTL) Diagnostics

- Significant FY98 funding ($220k) from LDRD
- Scope:
  - **Investigate optimal design for single-pass beam position monitor employing standard pickups**
  - **Implement button pickup design for trajectory control through LEUTL end-station undulators**
  - **Investigate optical diagnostics for LEUTL particle beam**
    - **Optical transition radiation (OTR)**
    - **YAG crystals**
    - **Far infrared transition/diffraction radiation**
- Status
  - **Three pickup electrode designs complete**
  - **Two designs in fabrication (stripline + small button)**
  - **S-band BPM electronics prototyping complete**
  - **Linac beam parameters quantified using OTR and YAG crystal methods (Linac stations 1 and 5)**

Geometry for BPM button geometry optimization



Optimization of BPM Sum, Position Sensitivity with Geometry



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